SCIENCE NEED STATEMENT

Detection/Distribution of Contaminants--Chemical Speciation and Complexation in Site-specific Groundwaters

Identification No.: RL-SS23-S
Date: September 2001

Program: Environmental Restoration
OPS Office/Site: Richland Operations Office/Hanford Site
Operable Unit(s): Broad need potentially applicable to multiple operable units.
PBS No.: RL-SS04 (RL-VZ01)
Waste Stream: Groundwater (Disposition Map Designation: ER-10 [technical risk score 5] and ER-18 [technical risk score 5]), Soil (Disposition Map Designations: ER-04 [technical risk score 3], ER-14 [technical risk score 5], ER-03 [technical risk score 3])
TSD Title:
Operable Unit (if applicable): N/A
Waste Management Unit (if applicable): N/A
Facility: N/A

***Priority Rating*:**

This entry addresses the "Accelerated Cleanup: Paths to Closure (ACPC)" Priority: Select a "1", "2" or "3" to assess the impact of the need/opportunity relative to the current site baseline.

_X__ 1. Critical to the success of the ACPC
____ 2. Provides substantial benefit to ACPC projects (e.g., moderate to high lifecycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays)
____ 3. Provides opportunities for significant, but lower cost savings or risk reduction, and may reduce uncertainty in ACPC project success.

***Need Title*:** Detection/Distribution of Contaminants--Chemical Speciation and Complexation in Site-specific Groundwaters

Need/Opportunity Category: Science Need

***Need Description*:** Determine the speciation and complexation of contaminants of interest in an aqueous phase distributed in (1) the vadose zone (pristine and contacted by tank waste liquids) and (2) the aquifer.

In order to detect and delineate the distribution of contaminants accurately in different media in a variety of hydrogeological settings at Hanford (e.g. vadose zone, aquifer), several aspects of science need to be addressed. It is important for design and selection of remedial alternatives to determine the inventory of the different contaminants at a given contaminated site: what contaminants are present, in what different forms, and in what amounts. The in-situ chemical

speciation of important contaminants (listed in the background section) as a function of the hydrochemical conditions of the Site is important to determining which dissolution/precipitation or oxidation/reduction reactions will immobilize or release contaminants. Measures are needed for solubilities of the different species as a function of the concentration of important cations and anions in uncontaminated and contaminated groundwater. While speciation can be modeled from bulk groundwater analyses, some direct measure of speciation, such as optical or emission spectroscopy, is needed to confirm models and assist in establishing contaminant mass balance. Basic scientific information on speciation contributes to the assessment of remedial alternatives.

Science needs also include knowing the range of aqueous complexes that contaminants form with common groundwater cations and anions, such as whether or not contaminants can be expected to occur as hydroxides, carbonates, sulfates, oxyanions, or as organic complexes. Knowledge of the solubility limits for these species in site-specific groundwaters assists in determining if aqueous complexes form surface complexes with secondary mineral surfaces.

A secondary need for information on contaminant speciation and complexation supports the development of accelerated analytical methods that can provide data on in-situ chemistry remotely and non- invasively. Some of the constraints include the need for these approaches to be remote, real-time, and either on-line or in-situ methods.

Schedule Requirements:

Earliest Date Required: 8/1/99

Latest Date Required: 9/30/15

***Problem Description*:** The Hanford Site is underlain by a vadose zone that ranges from less than 40 feet thick at the 100 Areas near the Columbia River to greater than 300 feet thick at the 200 Area. Recharge rates in pristine parts of the site are very low. Liquid waste disposal within the vadose zone has introduced numerous sources of contamination to the soil pore waters. High-level waste tanks have leaked varying amounts of sodium nitrate-hydroxide liquids contaminated with soluble radionuclides such as cesium and technetium. The chemistry of groundwater in the vadose zone will reflect the heterogeneity of waste streams that have been disposed. Likewise, the suprabasalt sediments beneath the Hanford site have several different facies, and therefore varying mineralogical, chemical, and hydraulic properties. The nature of the chemical reactions in this hydrogeologic setting will be specific to the types of pore waters, contamination, and primary/secondary minerals encountered, and data for the specific species and complexes encountered are a necessary prerequisite to adequate design of remedial technologies.

Benefit to the Project Baseline of Filling Need: If the science needs are filled, then alternative technologies may be developed and deployed to enhance the rate of remediation of the groundwater plumes at the Hanford site. Use of in-situ remedial technology rather than ex-situ treatment will reduce risk and provide cost savings

Benefit code: check all that apply:

- ✓ Cost Savings
- ✓ Risk Reduction
- ✓ Enabling Knowledge (i.e., solves a problem that cannot be remediated by current science/technology)

This Science Need also supports the following Hanford Subsurface Contaminant Technology Needs:

RL- SS28

Understand, quantify and develop descriptions of reactions and interactions between contaminants of concern and vadose zone sediments.

RL-SS34

Provide means to quantify the flux of contaminant between the groundwater and the Columbia River.

Relevant PBS Milestone: PBS-MC-042

End-User: Richland Environmental Restoration Project

Site Technical Point-of-Contact: Scott W. Petersen, BHI, (509) 372-9126; Mark D. Freshley, PNNL, (509) 372-9568; Michael J. Truex, PNNL, (509) 376-5461

Contractor Facility/Project Manager: Michael J. Graham, BHI, (509) 372-9179

DOE End-User/Representative Point-of-Contact: John G. Morse, DOE-RL, (509) 376-0057